

REMARKS

Favorable consideration and allowance are respectfully requested for currently pending claims 14, 19, 20, 22, 23, 25, 43 and 44 in view of the foregoing amendments and following remarks.

Claim 14 is amended to include the limitations of previously pending claims 15 and 17. The remaining claims are amended to provide proper dependency, as necessary.

The rejection of claims 14, 15, 23, and 25 under 35 U.S.C. § 102(e) over Glukhoy (6,783,629) in view of Ye et al. (6,178,920) and Tonotani et al. (6,181,069); the rejection of claim 17 under 35 U.S.C. § 102(e) over Glukhoy (6,783,629) in view of Ye et al. (6,178,920) and Tonotani et al. (6,181,069) and further in view of Wartski et al. (5,637,150); the rejection of claims 19, 20 and 22 under 35 U.S.C. § 103(a) over Glukhoy (6,783,629) in view of Ye et al. (6,178,920) and Tonotani et al. (6,181,069) and further in view of Minaee et al. (6,558,635); and the rejection of claims 43 and 44 under 35 U.S.C. § 102(e) over Glukhoy (6,783,629) in view of Ye et al. (6,178,920) and Tonotani et al. (6,181,069) and further in view of Noguchi (6,607,633) are all respectfully traversed.

The present invention relates to a plasma processing apparatus for supplying microwaves into a process chamber so as to generate plasma, wherein the chamber wall has at least one antenna so that the antenna penetrates the chamber wall into the inside of the process chamber; wherein at least one antenna is disposed in the process chamber, so as to provide a linear line; the antenna comprises a voltage-drawing rod for drawing a voltage from a waveguide or resonator disposed outside of the process chamber; and an insulating material surrounding the voltage-drawing rod; and the position of the voltage drawing of the voltage-drawing rod in the waveguide corresponds to $\{(1+2m)/2\}\lambda_g \pm (1/4)\lambda_g$, wherein λ_g is the guide wavelength and m is an integer from the terminal of the waveguide.

Based on this structure, the present invention can provide a plasma processing apparatus which can generate high-density plasma with a high efficiency, even in the case of the treatment of an object having a large area

(page 19, lines 8-11 of the present specification). Further, in the present invention, the chamber wall has at least one antenna so that the antenna penetrates the chamber wall into the inside of the process chamber, and the top plate has a plurality of holes for passing a gas to be supplied to the process chamber, and therefore such a structure can provide an improvement in the uniformity in the composition, concentration, etc., of a gas in the process chamber (page 13, lines 20-28 of the present specification).

In addition, because of the above structure, the voltage-drawing rod is protected by the insulating tube (a quartz tube, for example), so that the voltage-drawing rod 17 does not contact the plasma directly (page 10, line 31 to page 11, line 2 of the present specification). Further, because of the above position of the voltage drawing of the voltage-drawing rod in the waveguide corresponds to $\{(1+2m)/2\}\lambda_g \pm (1/4)\lambda_g$, the effective drawing of a high voltage can be achieved (page 12, lines 18-24 of the present specification).

None of the cited references, either alone, or in the proposed combinations teach or suggest a plasma processing apparatus for supplying microwaves into a process chamber so as to generate plasma, wherein the chamber wall has at least one antenna so that the antenna penetrates the chamber wall into the inside of the process chamber; wherein at least one antenna is disposed in the process chamber, so as to provide a linear line; the antenna comprises a voltage-drawing rod for drawing a voltage from a waveguide or resonator disposed outside of the process chamber; and an insulating material surrounding the voltage-drawing rod; and the position of the voltage drawing of the voltage-drawing rod in the waveguide corresponds to $\{(1+2m)/2\}\lambda_g \pm (1/4)\lambda_g$ from the terminal of the waveguide.

Glukhoy (U.S. Patent No. 6,783,629) discloses a plasma treatment apparatus for treating the surface of an object comprising: a sealed housing; at least one MW antenna for propagation of microwave energy; a source of MW energy for connection to the at least one MW antenna; and an oscillation drive means.

However, this reference does not teach or suggest a plasma processing apparatus wherein the position of the voltage drawing of a voltage-drawing rod in a waveguide corresponds to $\{(1+2m)/2\}\lambda_g \pm (1/4)\lambda_g$ from the terminal of the waveguide.

Ye (U.S. Patent No. 6,178,920) discloses a plasma reactor comprising: a) walls defining a chamber, the chamber being adapted to hold a workpiece within for processing with a plasma; b) an inductive antenna capable of generating a helicon wave for generating the plasma; and c) the antenna being secured within the chamber and wherein the antenna comprises a conductor embedded in a non-sputtering jacket, the jacket being attached to a chamber wall. This reference relates to an apparatus using helicon plasma using -RF (13.56MHz). In contrast, the present invention relates to an apparatus using microwave power.

Tonotani (U.S. Patent No. 6,181,069) discloses a high frequency discharging method, comprising the steps of: supplying high-frequency power to at least one linear antenna, the at least one linear antenna being eccentrically provided relative to the insulating covering to thereby generate an induction field and associated plasma in the container; and connecting a condenser to a side of the at least one linear antenna connected to ground,

This reference relates to an ICP using RF (400 MHz), and discloses a structure comprising an antenna surrounded by a dielectric material. On the other hand, the present invention relates to an apparatus using microwave power.

Wartski (U.S. Patent No. 5,637,150) discloses a device for forming a plasma from microwaves, comprising an ionization chamber including a gas-free volume into which a gas can be introduced to undergo excitation due to the presence of a high-frequency alternating electrical field emitted by a plurality of metal antennas disposed in the ionization chamber, wherein the metal antennas are disposed parallel, to each other and distributed at nodes of a regular plane network.

Noguchi (U.S. Patent No. 6,607,633) discloses a plasma generating device comprising: a wave guide for propagation of a microwave from a microwave

oscillating source; a radiative part, substantially perpendicular to the width and height, along which microwaves are propagated, the radiative part being connected to said wave guide for receiving microwaves therefrom and having a plurality of slot antennas disposed along the longitudinal dimension.

This reference teaches an ordinary type of microwave introduction method wherein an electromagnetic field enters the inside of a chamber via slots of a waveguide.

In contrast, the present invention relates to an apparatus having a structure wherein an antenna penetrates a chamber wall, and the antenna comprises a metal rod surrounded by a dielectric material. Accordingly, the apparatus according to the present invention has a different structure from that described by Noguchi.

However, none of the five cited references teach or suggest a plasma processing apparatus for supplying microwaves into a process chamber so as to generate plasma, wherein the chamber wall has at least one antenna so that the antenna penetrates the chamber wall into the inside of the process chamber; wherein at least one antenna is disposed in the process chamber, so as to provide a linear line; the antenna comprises a voltage-drawing rod for drawing a voltage from a waveguide or resonator disposed outside of the process chamber; and an insulating material surrounding the voltage-drawing rod; and the position of the voltage drawing of the voltage-drawing rod in the waveguide corresponds to $\{(1+2m)/2\}\lambda_g \pm (1/4)\lambda_g$ from the terminal of the waveguide.

Accordingly, the various proposed combinations of references fails to teach or suggest each and every element of the presently claimed invention. Further, it is not clear that the references are properly combinable given the varying power sources recited therein. Accordingly, reconsideration and withdrawal of these rejections are respectfully requested.

CONCLUSION

In view of the foregoing, the application is respectfully submitted to be in condition for allowance, and prompt favorable action thereon is earnestly solicited.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket No. 101249.52600US).

Respectfully submitted,

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